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Abstract

Fine sedimentation was quantified in the upper stretch of the Pellice river basin (Italian Alps), in an area partially interested by mining activities. Sediment traps were placed in fifty-two sites and benthic samples were collected to assess the amounts of coarse particulate organic matter and the structure of macroinvertebrate community. The results evidenced that the increase of fine sediments in the river reduced the amounts of coarse particulate organic matter, affecting the abundance of invertebrate shredders. In Alpine small streams, where allochthonous organic matter is the main energetic source, fine sedimentation reduces the availability of trophic resources, affecting the abundance of benthic communities.

Key-words: coarse particulate organic matter; macroinvertebrates; clogging; mining; allochthonous energetic inputs.

The increase of fine sediments has become a key problem in many rivers (Weigelhofer and Waringer 2003), particularly in mountain lotic systems which are characterised by coarse substrata because of high flow velocities and great tractive forces (Bona et al. 2008). Fine sedimentation affects benthic organisms directly (i.e. damaging soft body parts or decreasing habitat availability; Bo et al. 2007) or indirectly (i.e. altering trophic resources), with detrimental effects on invertebrate filterers (Jones at al. 2012) and scrapers (Kreutzweiser et al. 2005). In mountainous low-order lotic systems, the main energy source is represented by allochthonous organic matter, mainly terrestrial leaves (Tank et al. 2010; Bo et al. 2014). In such environments, storage and availability of benthic coarse particulate organic matter (CPOM) is influenced by a wide range of processes. Recent studies emphasized the importance of typology and abundance of in-stream structures in trapping and retaining allochthonous material (Small et al. 2008).

Little information is available about the impact of fine sediments on the retention of allochthonous organic material in alpine streams and its ecological effect on shredders (i.e. benthic invertebrates that feed on this resource). In this study, fine sedimentation was quantified using sediment traps, designed according to Bond (2002). The traps were randomly deployed in fifty-two spots in the upper part of the Pellice river basin (Italian Alps – Fig.1), in an area partially interested by mining activities (Sandrone et al. 2004). The traps were placed on 28 June 2013 and removed 17 days after. The sediments collected in the traps were returned to the laboratory, dried and sieved. Several studies dealt with sediment grain size (Wood and Armitage 1997; Kreutzweiser et al. 2005); in this study only the fraction <0.105 mm, belonging to 'very fine sand' in the Wentworth grain size classification, was considered (hereinafter fine sediment). We selected this fraction because

its occurrence is expected to be more 'unnatural' and related to mining activity in Alpine environments. At the removal date, one benthic sample was collected in each point to quantify CPOM and macroinvertebrate community, using a Surber sampler (250 µm mesh size; 0.062 m^2 area). The Surber were placed in the patches of streambed immediately after the removal of sediment traps, close (laterally) to trap sites. The traps collected a wide-ranging amount of fine sediments, fluctuating from a minimum of 1.64 g to a maximum of 64.7 g. Mean amount of trapped fine sediment was 16.9 g (± 2.27 SE). Also benthic CPOM showed high variability, ranging from 0.27 to 19.5 g/m^2. Mean amounts of CPOM weighted 3.86 g/m^2 (± 0.46 SE). In total, we collected 13,528 macroinvertebrates. Mean abundance in the substratum was 4,196.0 organisms/m^2 (± 451.5 SE). Regarding the functional composition of the invertebrate assemblages, collectors-gatherers were the most represented functional feeding group (75.1 %), followed by shredders (10.3 %), predators (8.4 %), scrapers (4.9 %) and filterers (1.3 %). The relative proportion of shredders showed a high variance, ranging from a maximum of 18.5 % to total absence. Plecoptera Euholognatha *Protonemura* sp., *Leuctra* sp. and *Nemoura* sp., followed by Diptera Tipulidae *Prionocera* sp. resulted the most abundant shredder taxa. Analysis of the relations between fine sediment and CPOM amounts and shredder abundance was performed with log-transformed data. Trapped fine sediments were significantly related with CPOM amounts ($t = -5.0995$, $cor = -0.58$, $p < 0.001$) and with shredder abundance ($t = -6.6847$, $cor = -0.69$, $p < 0.001$ – Fig. 2).

The presence of large mining areas and related intense road traffic in the sampled hydrographic system resulted in an increase of the fine sediment accumulation into the streambed. The presence of fine sediment homogenized the substrate, occluding the gaps and reducing morphological diversity and presence of elements that can trap and retain

coarse organic particles. In the most impacted sites we observed that stream boulders, small woods, and riverbanks were covered with a thick patina which probably could diminished their effectiveness as retention structures. The results evidenced that the increase of fine sediments in the river bottom directly reduced the amounts of CPOM, affecting the abundance of invertebrate shredders. Alpine lotic systems are facing increasing menaces because of local increase in human activities (Wohl 2006) and global effects of climate change (Fochetti 2012). In these environments, where allochthonous organic matter represents the main energetic source, fine sedimentation constitutes an important factor that reduces biodiversity and abundance of benthic communities.

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Figure 1: River Pellice basin and study area; black lines indicate sampled reaches, grey zone indicates mining area.

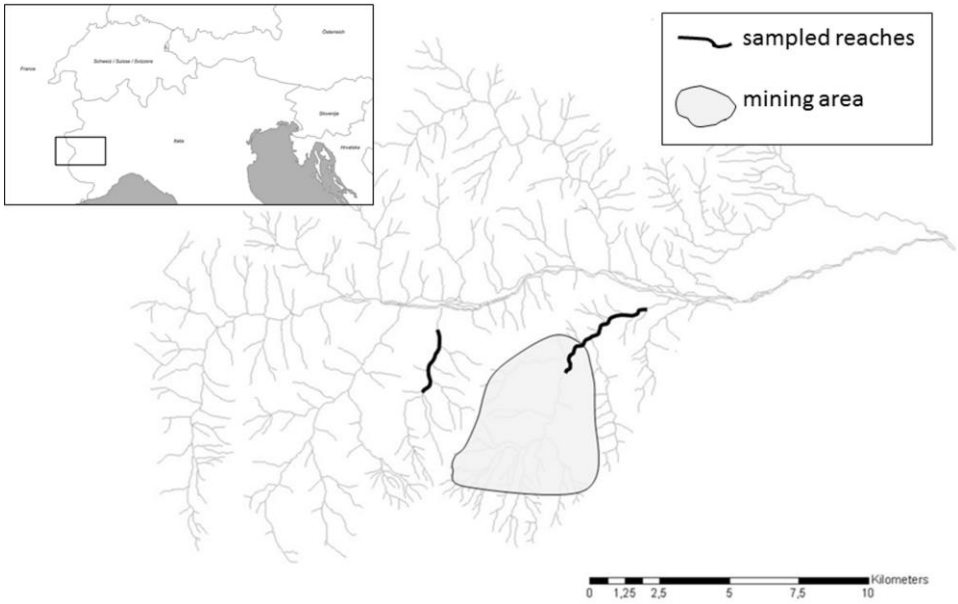
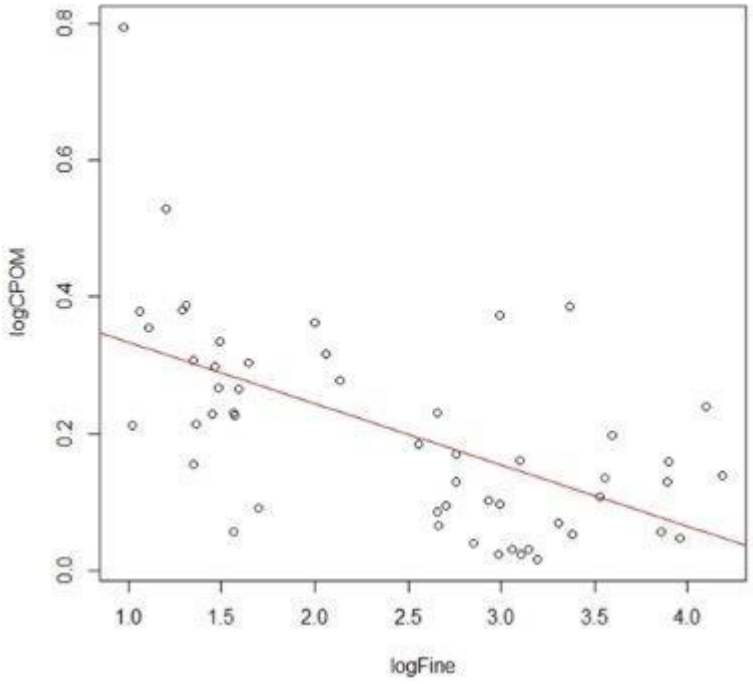


Figure 2: Relationship between fine sediment amounts and CPOM availability (above) and invertebrate shredder abundance (below).


logCPOM
0.0
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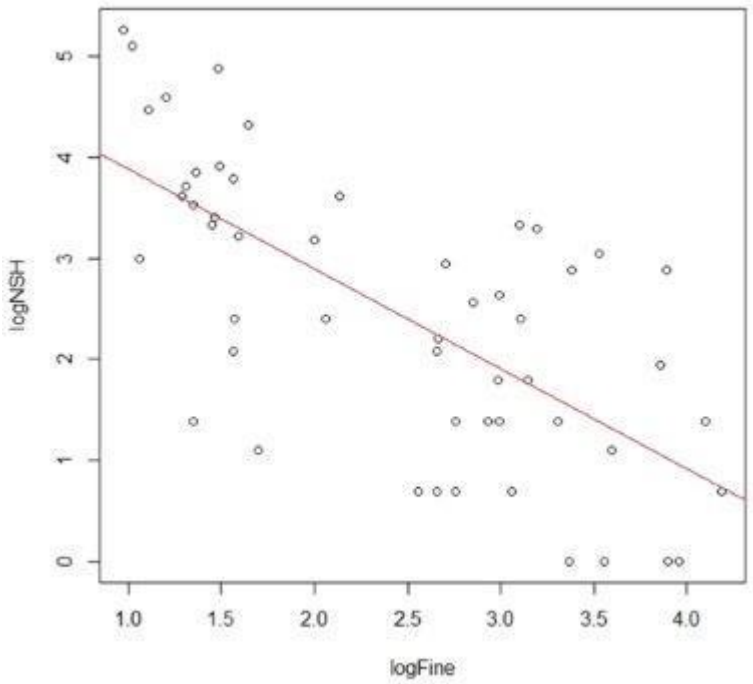
0.6
0.8
1.0
1.5
2.0
2.5
3.0
3.5
4.0
logFine


logNSH
0
1
2
3
4
5
1.0
1.5
2.0
2.5
3.0
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logFine